Granite Stone Meal

AS A SOURCE OF POTASH FOR TOBACCO

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In fertilization of cigar tobacco it is essential to furnish potash for "luxury consumption" in order to promote burn of the finished product. Hence, finding the most suitable potash-bearing materials is of great importance.

An "ideal" form is the potash carried in the organics, which are widely used in fertilization of Connecticut tobacco. However, the organics (cottonseed meal, castor pomace, etc.), are mainly used as carriers of nitrogen and only a limited quantity of potash is derived from that source. Tobacco stems are an excellent source, but some growers object to their use because they may be possible carriers of tobacco diseases. Continuous use is seldom practiced.

The common sources of commercially available potash, such as sulfate, nitrate, carbonate of potash and ashes, all have limitations in their usage. Too much sulfate of potash should not be employed because of its sulfur content. This element is commonly known to affect adversely the burn of tobacco and also, in excess, may impair the grading (quality) of the finished product. Nitrate of potash is limited because of the restricted usage of nitrate nitrogen in tobacco fertilizer. The general use of carbonate of potash and ashes is unsatisfactory because of their alkaline effect on the soil.

Recently, experiments were started with a type of granite stone meal with an unusually high content of total potash, obtained from granite quarries in Massachusetts.

The potash-bearing minerals in granite are the potash feldspars and the micas, of which the latter contain the most easily released potash. From time to time attempts have been made to utilize the material in agriculture. In 1912, Hiltner [2] working with seradella (a European fodder plant) in water cultures, observed that the plants grew vigorously in solutions to which acidic granite was added. Söderbaum[3] reported that granite meal gave good results as a source of potash. This was attributed to the fact that the potash was largely in the form of mica.

For the purpose of investigating the value of granite stone meal as a source of potash for tobacco, a series of tests was started here in 1947. The following is a report on results from three years of research.

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[1] Agronomist, Tobacco Laboratory, Windsor.

[2] Exp. Sta. Record Vol. 28, 1913. Ref. Prakt. Bl. Pflanzenbau u. Schutz 11 (1913) 2: 17-21.

[3] Exp. Sta. Record Vol. 28, 1913. Ref. Medd. Centr. Anst. Fors. Jordbr. 1912, No. 71: 19.

PRELIMINARY TESTS

The stone meal used in the investigations contained the following (approximate) amounts of minerals.[1]

Quartz	25%
Feldspars:	
Orthoclase, Microcline	54%
Plagioclase	10%
Micas:	
Biotite	3%
Muscovite	3%
Chlorite	3%
Accessory minerals:	
Epidote, titanite, rutile, apatite	2%
	100%

The potash content, claimed to be 8 per cent, was found to be as much as 11.7 per cent K_2O in one sample, when the material was boiled for five minutes in 5 per cent HCl solution. It is rather certain that the stone meal under investigation contained at least the claimed amount of total potash.

Employing the well known Neubauer technique (100 gms. of the material and 100 rye kernels for a growth period of 12 days), it was found that rye seedlings alone contained 58.5 mg. K_2O, and rye seedlings grown on stone meal 79 mg. K_2O. Thus, there was a difference of about 20 mg. absorbed from the stone meal. According to Neubauer, a soil test showing 20 mg. K_2O would be equivalent to 535 pounds of potash to the acre. It was evident that stone meal would furnish absorbable potash by the simple action of exuded carbon dioxide from the roots.

In the fall of 1947 a section of a shade tobacco field which had a very low content of available potash received stone meal at the rate of two tons to the acre. Rye was seeded as a cover crop. The following spring when the rye was about seven inches tall, seedlings were cut off at the ground surface in four different places on the treated plot and the same procedure was followed on an adjacent untreated section which had a satisfactory potash supply in the soil. The samples were dried, powdered, and examined for potash content. The rye from the control area contained 2.62 per cent K_2O, and that from the section treated with stone meal 2.73 per cent K_2O. It is thus suggested that the stone meal furnished *absorbable* potash. Part of this potash, however, may not be detected by accepted soil testing methods, since it comes from a so-called non-available form.

A number of acids are formed in the soil in decaying processes, as a result of the activity of microorganisms. Nitric acid is formed in the nitrification of the great quantities of organics applied annually to tobacco land.

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[1] The material and analytical data obtained from R. A. Fletcher, West Chelmsford, Mass.

Stone meal may be acted upon by a relatively weak solution of a strong acid, such as nitric acid produced in the nitrification processes in the soil.[1] Furthermore, a portion of the stone meal will probably be in a colloidal suspension in the soil moisture, when it is applied to the land, and it should be rather easily attacked.

FIELD EXPERIMENTS IN 1947

A preliminary field test with granite stone meal was undertaken in 1947. The stone meal used contained 11.7 per cent K_2O (potash soluble in 5 per cent HCl). A great portion of the material was in the form of a fine dust.

Stone meal was applied at two rates: two tons and one ton per acre. The stone meal was to serve as the main source of potash. Sulfate of potash, applied at the rate of 335 pounds per acre, was the major source in a check treatment. This furnished 160 pounds K_2O which, together with 40 pounds in cottonseed meal, provided 200 pounds of K_2O to the acre.

The following fertilizer ingredients were used per acre on both stone meal and sulfate of potash plots.

2000	lbs.	Cottonseed meal
200	"	Ammonium nitrate
200	"	Precipitated bone
300	"	Limestone

In addition, two control plots were included which received no commercial fertilizer or potash applications. All plots (1/80 acre each) were laid out in duplicates for each treatment.

The parcel of land on which the test was conducted was a Merrimac fine sandy loam of high fertility (pH 5.68, high P, very high K, high Ca and very high Mg). In other words, it was a typical old tobacco soil, which receives annual applications of 200 pounds K_2O per acre.

Havana seed tobacco was planted on the entire field. As a criterion of the fertility of the land *per se* it was noticed that tobacco grew quite well but rather short on the "no fertilizer" plots. After harvest and proper curing of the crop, yield and grading data were secured as compiled in Table 1.

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[1] In order to learn how such a concentration (0.1 per cent) of HNO_3 solution would affect the release of potash in stone meal, the following test was made. Two 100 gram portions of the material were shaken with .1 per cent (about .02 N) solution of HNO_3 for one-half hour. The same test was made with distilled water.

The HNO_3 extract became perfectly clear after centrifuging (2,000 r.p.m. 15 minutes), while the water extract had a colloidal suspension. This was deflocculated in the acid extract, which showed a pH value of 4.0. The water extracts were analyzed for potash and it was found that the HNO_3 extract released 1.14 per cent K_2O while the water extract released .49 per cent K_2O. In the water extract, materials in suspension were included; very little, if any, potash could possibly be water-soluble.

Table 1. Yield and Grading Records of Stone Meal Plots, 1947

Source of potash	Plot No.	Yield lbs. per A. Plot	Yield lbs. per A. Av.	Grade Index [1] Plot	Grade Index [1] Av.	Crop Index [2]
None (no fertilizer)	1	1400	1400	.356	.342	478.8
" " "	2	1400		.327		
Sulfate of potash	1	2346	2212	.479	.490	1083.9
" " "	2	2047		.501		
2 tons of SM[3] per A.	1	2106	2061	.522	.494	1018.1
" " " " " "	2	2015		.466		
1 ton of SM per A.	1	2038	2169	.419	.436	956.5
" " " " " "	2	2300		.463		

[1] Grade index is a figure which represents the *relative* value of a lot of tobacco computed on the percentage weight of each grade of leaves in the lot and the relative values of these grades. Assuming that the light wrapper is the perfect leaf of Havana seed tobacco, we assign to it a value of 1. The other grades are assigned values of the same proportion to 1 as their market value was to the price of the light wrapper when this system was established. Thus, medium wrappers have a value of .60; long seconds (19 inches or more) are .60; short seconds (15 inches and 17 inches) are .30; long darks are .30; dark stemming (short darks of 15 inches and 17 inches) are .20; fillers and brokes are .10. It is true that the values of these grades have fluctuated considerably during the 15 years that we have used this system of comparing lots of tobacco, but in order to be able to average results over a period of years it seems advisable to retain the same system for the present. To obtain the grade index figure, the percentage of each grade in a lot of tobacco is multiplied by the relative values noted above and then the products are added.

[2] Crop index is the product of grade index and yield.

[3] Stone meal.

Here it is seen that two tons of stone meal per acre as the main source of potash produced fully as good a grading of tobacco as that grown with sulfate of potash. The one-ton stone meal application resulted in somewhat lower grading. (Yields are not affected by potash, unless there are great excesses in the soil, in which case there would be a decrease in yield).

Using the no-fertilizer plots as a basis for calculation, the fertilizer containing sulfate of potash produced 43 per cent improvement in grading and that containing stone meal 44 per cent.

Potash is a necessary agent in promoting burn of cigar tobacco. Therefore, burn tests [1] on the leaf would give *direct* information on the burning qualities and *indirectly* on potash content. Such tests were made on the lower leaves ("seconds") of plants from the various treatments.

The results were:

	Relative value
Leaves from plots with no added fertilizer held fire 40 seconds	67
Leaves from 1 ton stone meal plots held fire 50 seconds	83
Leaves from 2 tons stone meal plots held fire 50 seconds	83
Leaves from plots with potassium sulfate held fire 60 seconds	100

A duration of burn for 50 seconds is considered very satisfactory. Durations of 60 seconds or more sometimes result in darker colored ash and inferior aroma when leaf is burned in a cigar.

[1] Burn tests are made by stretching the tobacco leaf taut between the hands and touching it to a hot electric filament. The number of seconds the leaf remains glowing (without flame) is recorded as "duration of burn".

FIELD EXPERIMENTS IN 1948

In order to study more closely the absorbability of potash in stone meal, a field was selected with soil of very low content of available (replaceable) potash. It had grown corn and vegetables for three years and had been "rested" in wild grasses for the last two years.

Enough plots (1/80 acre in size) were laid out to obtain quadruplicate tests for the following treatments:

1. Check—potash furnished in regular commerical 6-3-6 mixture, applied at the rate of 3,400 pounds per acre.
2. Regular stone meal as source of K_2O (1 ton per acre).
3. Finely ground stone meal as source of K_2O (1 ton per acre).
4. Sulfate of potash as source of K_2O (equiv. to 200 lbs. K_2O per acre).
5. No potash.

In all treatments the nitrogen and phosphoric acid were applied at equal rates. The plots were randomized within four blocks. A test on finely ground stone meal (coarser material sifted off) was included to see if the finer material would furnish more easily absorbable potash.

Soon after fertilizer application, the field was planted with Havana seed tobacco. The growth was very uneven, with no apparent correlation to treatments. Examination of roots from tobacco plants revealed a heavy infestation of nematodes. The plots were carefully hand hoed to encourage the plants to set new roots above the injured ones. At the end of the season, the crop advanced sufficiently to permit harvest for data.

Because of the erratic growth, yield and grading data were adjusted on four plots where they seemed unreasonably out of line. For this calculation a so-called "missing plot" technique was employed. As indicated in Table 2, there was no significant difference between the treatments.

Table 2. Yield and Grading Records of Stone Meal Plots, 1948

Source of potash	Plot No.	Yield lbs. per A. Plot	Yield lbs. per A. Av.	Grade Index Plot	Grade Index Av.
Standard 6-3-6 mixture	A	2156		.502	
	B	1645[1]	1794	.319[1]	.395
	C	1550		.328	
	D	1875		.431	
1 ton *regular* stone meal per acre	A	1819		.510	
	B	1558	1671	.310	.386
	C	1630[1]		.330[1]	
	D	1676		.393	
1 ton *fine* stone meal per acre	A	1712		.309	
	B	1641	1669	.356	.335
	C	1688		.338	
	D	1636		.338[1]	
Sulfate of potash	A	1969		.411	
	B	1745	1817	.351	.379
	C	1941		.425	
	D	1613		.330	
None (no fertilizer)	A	1125		.198	
	B	1565	1495	.219	.258
	C	1551		.303	
	D	1737		.311	

[1] Corrected data.

Here again, the grading with regular stone meal was higher than with sulfate of potash. The finely ground stone meal rated lower than either. As will be seen later in the analytical data, the fine material furnished less absorbable K_2O than the regular stone meal. It is possible that the fine material contained less potash-bearing minerals and probably more pure silica.

The relative rank of grading would be standard mixture, 100; regular stone meal, 97.7; sulfate of potash, 95.9; fine stone meal, 84.8, and no potash, 65.3. It is reasonable to assume that, if the relative grading value of the control (no potash) be subtracted from the treatment values, a fair evaluation of the potash effect would be obtained, with the following result:

Standard mixture	=	34.7
Regular stone meal	=	32.4
Sulfate of potash	=	30.6
Fine stone meal	=	19.5

With a rate of only one ton giving such favorable results, it seems likely that stone meal applications would have surpassed the check, if a two-ton rate had been used. The total amount of potash supplied by the stone meal treatment was about the same as in the standard mixture. However, while in the latter case all the potash was to be considered as water-soluble, none of the stone meal potash was present in that form, nor as exchangeable potash. This latter form can be detected by simple microchemical test.

Part of Stone Meal Forms Replaceable Potash

Soil tests made in the middle of the 1948 growing season showed that part of the potash in stone meal will form replaceable potash in the soil.

The replaceable potash for the different treatments given below are the averages of four plots.

Control (no K_2O)	136	p.p.m.	K_2O
Regular stone meal	155	"	"
Fine stone meal	157	"	"
Sulfate of potash	198	"	"
Check (standard 6-3-6)	252	"	"

In approximate pounds per acre the rank is:

Control (no K_2O)	272
Regular stone meal	310
Fine stone meal	314
Sulfate of potash	396
Standard 6-3-6	504

As would be expected, the plots receiving standard fertilization with more than two sources of potash, possessed the greatest amount of replaceable potash. With several sources of potash in the soil, there is a varied cation-anion combination. The process of exchange, therefore, will persist for a longer period of time, until something happens to the exchange material—it either becomes fixed, absorbed by the vegetation or to some extent is lost by leaching; a fraction may revert to the mineral stage.

Approximately 15 per cent of the potash in stone meal was found to change into a replaceable form, based on the difference between the potash present in the control soil and that from the stone meal treatments. While there is no immediate advantage of this kind of exchange, the results suggest that applications of stone meal to the land ultimately will raise the level of available potash.

Deposit of Potash in the Leaf

Leaf samples were taken from grades of "seconds" and "darks" and prepared for chemical analysis. By the standard method, potash content was determined and the results are given below:

		% K_2O	*Av. % K_2O*
Control (no K_2O)	Seconds	2.674	2.35
	Darks	2.035	
Fine stone meal	Seconds	2.848	2.63
	Darks	2.403	
Regular stone meal	Seconds	3.690	3.29
	Darks	2.906	
Sulfate of potash	Seconds	4.224	3.90
	Darks	3.585	
Check (standard 6-3-6)	Seconds	5.115	4.43
	Darks	3.740	

In calculating the amount of potash removed from the soil by a tobacco crop, it is generally considered that stalks and roots absorb as much as the leaves. From the yield figures given in Table 2 the resumé below elucidates the usage of absorbable potash:

Control (no K_2O)	68	pounds K_2O per acre
Fine stone meal	88	" " " "
Regular stone meal	110	" " " "
Sulfate of potash	142	" " " "
Standard 6-3-6	159	" " " "

If the removal by the "control" be subtracted from that of the various treatments, it may be assumed that the difference was due to potash added in the fertilizer.

Fine stone meal	20	pounds K_2O per acre
Regular stone meal	45	" " " "
Sulfate of potash	77	" " " "
Standard 6-3-6	94	" " " "

The results above indicate that about half of the potash in regular stone meal was utilized, as compared with the "standard" and approximately 60 per cent in comparison with sulfate of potash.

It should be recalled that stone meal contained from 8 to 11.7 per cent total potash. When only 50 to 60 per cent of that amount, or some 100 pounds of beneficial potash were supplied in one ton of stone meal per acre, it would seem necessary to apply stone meal at the rate of two tons to the acre, in order to promote the luxury consumption of potash, so essential for proper burn.

Burn Tests

The burning quality of a cigar leaf is in a narrow sense the fire holding capacity, that is, the length of time it remains glowing (without flame) once it is ignited. The duration of the burn is somewhat in proportion to the amount of potash deposited in the leaf. In the previously discussed burn test where tobacco had been grown on old tobacco land, high in available potash, duration of burn was at a top level.

The results given in the resumé below are from burn tests of the 1948 crop, which was grown on land very low in exchangeable (replaceable) potash. The fairly dry season also may have contributed to a burn of a lower level than in 1947.

	Av. duration of burn seconds	*Relative value*
Standard 6-3-6	8.04	100
Regular stone meal	7.32	91
Sulfate of potash	6.25	78
Fine stone meal	5.61	70
Control	4.05	50

These data are based on 40 tests from each treatment. It is of interest to note that the regular stone meal ranked next to the standard fertilizer, while sulfate of potash ranked third. It is possible that the sulfur radical adversely affected the burn, notwithstanding the higher potash content of the leaf (see analyses on page 9). Moreover, in this test, the regular stone meal ranked relatively closer to the standard than in 1947, i.e., 100 to 91, as compared with 100 to 83.

FIELD EXPERIMENTS IN 1949

In the 1949 experiments stone meal was used as one of the sources of potash in a complete fertilizer mixture. A field was selected that was adjacent to the 1948 test field. The potash content of the soil was medium to low, but the balance of the nutrient constituents showed a satisfactory level.

The fertilizer formula was compiled on an acre basis as follows:

2,000	pounds	Cottonseed meal
600	"	Castor pomace
50	"	Uramon
2,000	"	Granite stone meal
200	"	Cottonhull ashes (35% K_2O)
200	"	Precipitated bone
300	"	Dolomitic limestone
20	"	Borax
20	"	Copper sulfate

This acre-dosage furnished 200 pounds of nitrogen (N), 120 pounds of phosphoric acid (P_2O_5), and 200 pounds of potash (K_2O), of which the stone meal was expected to supply about 90 pounds. Four 1/40 acre plots received this treatment. Four check plots were treated with the same formula,

except that stone meal was omitted and 90 pounds of potash was furnished in the form of sulfate of potash. The plots were laid out in one tier so that every other plot received the stone meal formula, and alternate plots were checks.

Since the soil in this section was heavily infested with nematodes in 1948, the entire field was fumigated with ethylene dibromide. Ten days later the fertilizers were applied and the field was planted to Havana seed (K1 type).

Good growth was observed all through the growing season, which, however, was extremely dry. It was necessary to irrigate the field five times during the season, at about a week to 10 days' intervals.

In August the crop was harvested and, after proper shed curing, it was graded in November. The results of weighing and sorting at that time are recorded in Table 3. As would be expected, no significant differences are to be found in yield or grading between the two treatments, although the yield as well as grade index (quality) is somewhat higher for the stone meal than for the check. Considering both yield and grading, the stone meal produced a crop value nearly 5 per cent higher than the check.

TABLE 3. YIELD AND GRADING RECORDS FROM STONE MEAL EXPERIMENT, 1949

Treatment	Plot No.	Yield lbs. per A. Plot	Yield Av.	L	M	LS	SS	LD	DS	F	B	Grade index Plot	Grade index Av.	Relative crop value (crop index)
Check. K_2O derived from sulfate of potash, cottonhull ashes and organics	1	1898	2008	4	4	32	8	33	9	7	3	.407	.426	(855.41)
	2	2000		5	5	30	7	34	7	9	3	.409		
	3	2097		4	4	41	6	31	5	6	3	.440		
	4	2037		2	3	48	4	31	4	6	2	.447		100.0
Stone meal substituted for sulfate of potash, otherwise as above	1	2072	2066	5	6	35	6	35	3	7	3	.435	.434	(896.64)
	2	2152		7	2	35	6	32	7	8	3	.431		
	3	1914		5	3	39	6	28	7	8	4	.440		
	4	2125		5	9	30	9	32	7	7	1	.429		104.82

Burn Tests

Burn tests on leaves from the 1949 crop gave the following results:

		Burn, number of seconds: *Seconds*	*Av.*	*Darks*	*Av.*	*Average of seconds and darks*
Check	1	32	17.5	5	5.5	11.5 seconds
	2	12		3		
	3	12		8		
	4	14		6		
Stone meal	1	23	17.0	6	8.0	12.5 "
	2	13		5		
	3	14		14		
	4	18		7		

There was practically no difference in duration of burn, whether tobacco was grown with common sources of potash or with stone meal as a substantial part of the potash supply.

In a test where leaves from the two treatments were finely ground and ashed on a hot plate, the ash color was considerably lighter with stone meal tobacco than with that grown with sulfate of potash. Thus, according to Ridgway's Color Standards, Plate LI, the stone meal-ash color appeared to compare with Pallid and Pale Mouse Gray, and that of the check-ash fell between Light Mouse Gray and Mouse Gray. The check, therefore, was one shade darker than the ash resulting from stone meal. Also, the smoke from the stone meal tobacco had a fragrant odor which was entirely lacking in the check tobacco.

Potash Content of the Leaf

In view of the satisfactory burn produced by tobacco grown with stone meal, it was of interest to learn to what extent potash had been deposited in the leaf.

Chemical analyses showed that stone meal tobacco contained 3.05 per cent K_2O and the standard fertilizer tobacco 3.76 per cent. Burn tests indicated that stone meal gave fully as good a burn as sulfate of potash, but with less potash present in the leaf. It is possible that sulfur from the sulfate radical in the potash salt was absorbed to an extent sufficient to retard the burn. The relatively low potash content of all tobacco in the experiment resulted from the low level of potash in the soil.

Trace Elements

Trace elements are often referred to as minor elements. Many of these, however, are as important to normal plant growth as any of the major elements. Their role in plant nutrition has been studied extensively in recent years.

Besides silica, iron, aluminum, potassium, calcium and magnesium, the granite stone meal used in these experiments contained traces of copper, zinc, titanium, nickel, chromium, manganese and lead, as disclosed by spectrographical tests. Traces of boron, silver and vanadium were possibly present, but no molybdenum was detected.

Quantitative spectrographical analyses [1] of the tobacco leaf in the experiments with granite stone meal revealed an average content of about 102 parts per million of boron (B) as against 90 parts per million for the check. Copper (Cu) was found to be deposited to the extent of 37 parts per million in the stone meal tobacco as compared with 21 parts per million in the check. Corresponding figures for zinc were .036 and .024 per cent. In all instances, there was considerably higher content of these elements in the stone meal grown tobacco than in the check. This suggests that trace elements carried in the stone meal are available to some extent.

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[1] These were furnished by the Department of Analytical Chemistry.

DISCUSSION

With some 24,000 pounds of total potash per acre in Connecticut tobacco land, it will probably never be possible to devise means to make a major part of it available to tobacco. Through continuous tobacco farming, available (replaceable) potash increases to an average of about 400 to 500 pounds (K) per acre.[1] Changing the cultivation to other crops will soon lower the amount of available potash, and in abandoning the land, the potash reverts to its original status.

Although the larger part of the total soil potash is non-available, a part may be released for plant growth through the action of organic acids and acids formed directly through the fertilization.

Part of the fertilizer potash applied to the land may become *fixed,* and this form is more easily made available than the non-available type.

Most of the fertilizer potash is converted into an *exchangeable* form in the soil rather soon after application, and a very small fraction remains *water soluble.*

The writer agrees with the opinion of many investigators [2] that the plant itself provides a substantial part of *absorbable* potash through carbon dioxide exudation by the roots, together with that formed by soil organisms. The resulting carbonic acid liberates potash of various forms, so that there would be a steady supply of absorbable potash in the root zone. Obviously, this weak acid is most effective in attacking the exchangeable portion and temporarily fixed forms [3] of potash.

In assuming that potassium bicarbonate, $KHCO_3$, is formed, this compound is readily dissociated and the very mobile K ion is rapidly absorbed by the root system. The freed HCO_3^- radical may continue to liberate more potassium from the soil complex. The carbonic acid postulate is presented in an attempt to explain the *absorbability* of potash. The results from the experiments with granite stone meal indicated that about 50 per cent of the potash present in that material is utilized by the tobacco crop. Through the action of soil acids and the buffering activities of constituents of the stone meal, the potash (due to its great mobility) is released and is either absorbed by the crop or converted into a replaceable form. Granting, however, that the process is slow, possibly too slow for the luxury consumption required by tobacco, stone meal may serve as *one* good source of potash; in fact, one of the few, if not the only one, possessing no restriction for extensive use (see page 3).

For more than 300 years crop after crop has been removed from Connecticut tobacco land. To be sure, through manuring, commercial fertilizers and, in the last generation, extensive cover cropping, the land has maintained its production capacity. However, there may be some truth to sayings by "old-timers" among tobacco men that tobacco produced nowadays in Connecticut possesses nothing like the flavor and aroma for which this tobacco always has

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[1] M. F. Morgan. The soils of Connecticut. Conn. Agr. Exp. Sta. Bul. *320:* 884-885. 1930.

[2] H. Lunegardh. Mineral nutrition of plants. Annual Rev. Biochem. Vol. *16:* 503-528. 1947.

[3] Peech, Michael. Chemical methods for assessing soil fertility. Diagnostic Techniques for Soil and Crop. p. 11-14. 1949. Washington, D. C.

been well known. It is possible that continuous cropping has drawn heavily on the supply of some of the mineral soil constituents, which undoubtedly have a bearing on the quality of Connecticut tobacco.

Granite is one of the most common rocks that contributed to formation of Connecticut soils.[1] It is thus possible, by a systematic addition of fresh granite material to Connecticut tobacco land, to build up gradually and replenish some of the trace elements essential to plant growth and also some elements which may have an effect on the specific quality of Connecticut tobacco.

SUMMARY

Granite stone meal used in the experiment carried a total potash content of at least 8 per cent. In addition, the material contained small amounts of Ca and Mg, and traces of B, Cu, Zn, Ti, Ni, Cr, Mn, Pb and, possibly, V and Ag.

It was shown that the total potash in stone meal was released by boiling in 5 per cent HCL solution.

Neubauer tests with stone meal revealed that the root action of rye seedlings released as much potash as would correspond to more than 500 pounds K_2O per acre in soil.

A solution of about .02 *N* HNO_3, corresponding to the nitric acid (nitrate) produced in a properly fertilized tobacco field, released 1.14 per cent of the potash in stone meal.

An application of two tons of stone meal per acre, combined with the usual amount of nitrogen and phosphoric acid, produced fully as good a yield and quality as a standard 6-3-6 formula.

Better burn and lighter color of ash was obtained with stone meal, yet somewhat lower potash was deposited in the leaf tissue.

With stone meal as one of the sources of potash in a tobacco fertilizer, the crop value was increased nearly 5 per cent. Burn was fully as good with stone meal as with standard sources of potash; and lighter colored ash was produced, accompanied by fragrant odor of the smoke.

[1] M. F. Morgan. The soils of Connecticut. Conn. Agr. Exp. Sta. Bul. *320:* 836-837. 1930.